

## Education and the importance of the first educational choice of the FAMSIM+ Family Microsimulation Model for Austria

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Veröffentlichungsversion / Published Version

Arbeitspapier / working paper

### Empfohlene Zitierung / Suggested Citation:

Spielauer, M., Schwarz, F., & Schmid, K. (2002). *Education and the importance of the first educational choice of the FAMSIM+ Family Microsimulation Model for Austria*. (Working Paper / Österreichisches Institut für Familienforschung, 15). Wien: Österreichisches Institut für Familienforschung an der Universität Wien. <https://nbn-resolving.org/urn:nbn:de:0168-ssoar-57507-2>

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working paper



Österreichisches Institut für Familienforschung  
Austrian Institute for Family Studies



Institut für Bildungsforschung der Wirtschaft

Nummer

15 – 2002

Titel

**„EDUCATION AND THE IMPORTANCE OF THE FIRST  
EDUCATIONAL CHOICE IN THE CONTEXT OF THE  
FAMSIM+ FAMILY MICROSIMULATION MODEL FOR  
AUSTRIA“**

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## 1 Introduction

This OIF working paper written in collaboration with the Institute for Research on Qualification and Training of the Austrian Economy can be seen as the second instalment of a series of working papers, describing the microsimulation modelling activities of the socioeconomic unit of the Austrian Institute for Family Studies (OIF) since the publication of the FAMSIM prototype in 1997 (Lutz 1997). These research activities eventually will lead to a comprehensive FAMSIM+ family microsimulation model for Austria. In the first issue "Family Microsimulation" (Neuwirth, Spielauer 2001), we estimated the original FAMSIM model for five European countries and presented estimation and simulation results for these countries, together with an outlook on future model developments and improvements. One of the announced improvements regards the modelling of education, both to acknowledge the great importance of education on the human life course as well as to overcome the rather superficial treatment of education in the prototype version of the FAMSIM model. Besides that the modelling of the first educational choice between lower secondary and lower academic secondary school provides the logical starting point for the improvement of our model, as the choice between these alternative school types is the first life course event after the birth modelled in FAMSIM+.

Education plays a crucial role in family and household projections as it was identified as the single most important variable besides age and sex in determining fertility and mortality (Lutz 1999). Regarding the timing of life events, most other life careers (i.e. household formation, marriage and parenting) usually start after leaving school, while in economic modelling, education is a key determinant of human capital and therefore of income and job careers. Education attainment is an indicator of differences between individuals in many dimensions: it might be a measure of talent, income potential, social status and class as well as individual autonomy, i.e. independence of partners and, perhaps, also of general norms in society (Hoem et.al., 2001).

In the context of most microsimulation models, education constitutes the first individual career that is simulated, as formal education starts early in life. Existing microsimulation models differ considerably in their ways of modelling educational careers, ranging from rather simple approaches that summarise education using a few variables (e.g. school leaving age and/or highest grade) to the detailed reproduction of national school systems and all possible transition paths. An example of the first type is the French DESTINIE (Bonnet, Mahieu 1999) pension microsimulation model. DESTINIE does not model school careers per se but determines the school-leaving age that also serves as a proxy for educational attainment. In this model school-leaving age is determined as soon as a person is born in a two-step process. First, it determines the average school leaving age of the cohort and then the individual deviation from that number, with parental school-leaving ages entering the calculation. In the following, this age enters the equations of the labour market and the income module as well as all demographic modules.

As information on the institutional characteristics of the school system is usually available, microsimulation can go into any detail regarding school types and educational careers. In principle it might even link individual agents to individual schools or universities. An example of a microsimulation project including detailed regional characteristics and reproducing a national school system is the Swedish SVERIEGE model. (Vencatasawmy 1999)

For the purpose of the FAMSIM+ project, individual educational careers will be simulated making use of available information, i.e. enrolment rates and using a simplified model of the Austrian school system, which is detailed enough to incorporate the main features, that is, the general structure as well as the main transition paths with respect to gender. By doing so, we alter the FAMSIM approach, that has so far made exclusive use of Family and Fertility Survey (FFS) data. School systems usually feature a series of national characteristics. As for Austria, one of those characteristics is the comparatively early decision between alternative school types that highly influences the future educational career. Given the rich data usually also available for other countries and the national differences in systems, leaving the road of only using internationally available and standardized datasets seems justified, as the "national roads" of alternative education careers might join again later in a comparative setting.

For the study carried out in this paper, microcensus data was used, with the sample size being the dominant motivation, as we limited analyses to variables that are basically also available in FFS data.

FAMSIM+ is a general model in the sense that it is not specialized for a very limited purpose or limited to a small group of individuals or households, and that it contains more than a single or just some behavioural relations (Klevmarken 1997). This opens a wide spectrum of possible applications, including detailed educational projections and the study of interactions between education and other life course career paths, i.e. job careers. Besides its future use in family studies (i.e. the evaluation of costs and (re)distributional effects of certain family policy measures) the general character of the FAMSIM+ model should invite researchers of fields other than family studies both to use FAMSIM+ and to incorporate their specific strengths and expertise in the building of the FAMSIM+ model. In the context of the modelling of education careers, such a collaboration was established with the Institute for Research on Qualification and Training of the Austrian Economy (IBW) making this working paper also the first contribution of this cooperation.

Educational projections usually share one characteristic with population projections in the narrow sense (by age, sex and a few other characteristics like education): they are usually produced by cell-based macro models rather than microsimulation. In education projections based on observed (or otherwise projected) transition rates between school types and grades, i.e. by sex, microsimulation would not add anything (but monte-carlo variation) to the model. Including more variables into the model – like educational attainment of parents and regional characteristics in the context of that paper – microsimulation increasingly gains in attraction compared to cell-based approaches that soon become intractable as the number of cells grows geometrically by the possible values of the variables added. While both approaches might be two alternative methods for making similar statements about the future, no alternatives exist

to microsimulation in a number of other applications. These include all models that have to keep track of individual histories, for example:

- models that include Non-Markov processes, that is, models that include processes in which "history counts" (i.e. a model in which the repetition of a school grade would influence the future school career or in which the graduation from a specific school type would influence the performance in the actual school type etc.).
- models that include individual accounts, such as taxes paid, transfers received or opportunity costs, i.e. of being in school, that might be needed to calculate returns to educational investments.
- models that quantify incentives, i.e. to continue education for given individual characteristics.
- models in which a link to parents and other relatives is established in order to include their (dynamically changing) characteristics in behavioural equations. Such links are also of importance in tax benefit models, as the calculation of taxes and transfers (i.e. grants) might be influenced by family and household characteristics.

A general microsimulation model that was initially used in the field of education (for the evaluation of the Swedish national system of study allowances) is the Swedish SESIM model (Ericson, Hussenius 1998) developed by the Swedish Ministry of Finance in collaboration with researchers from different universities.

The analysis of school choices carried out in this paper shows the strong influence of the educational attainment of parents. While only 10% of the children with parents of the lowest of the four educational levels distinguished enter a secondary academic school – a choice to be made at the age of 10 – more than 80% of the children with parents with the highest education level do so. Microsimulation allows to study the dynamics generated by the changing educational composition of parents over time and the inclusion of parental characteristics in the modelling of education in FAMSIM+ is expected to improve the model considerably.

## 2 Characteristics and Development Tendencies in the Austrian Education System

As already mentioned, to understand the characteristics and dynamics of school choice and educational biographies (and their impact on the life course) better, one has to implement behavioural models into the context of the structure of an educational system. Before describing our approach, some important background information of the Austrian educational systems and its evolution over time will be presented briefly (see also the representation of the Austrian educational system of diagram 1 in the appendix).

Compulsory schooling starts in September following the child's sixth birthday. Their "educational career" begins with the attendance of primary school, which has the task of imparting a common elementary education to all children. After primary school, at the so-called secondary level I, there is a first differentiation into two types of schools: lower secondary school (*Hauptschule*) and the lower cycle of academic secondary school (*Allgemeinbildende Höhere Schule, AHS*). Up to the eighth grade, mainly general education is imparted. One year before completing general compulsory schooling, students have to decide on their further educational career. This final year of compulsory schooling (grade 9) may be completed at pre-vocational school (*Polytechnische Schule*), or in grade one of a secondary technical and vocational school or college, or in the fifth year of AHS. After compulsory schooling, at secondary level II, the Austrian education and training system basically offers three alternative education and training tracks: the dual system; full-time school-based vocational education and training (BMS and BHS); and AHS. The post-secondary level comprises university-based (incl. the universities of art and music) and non-university-based educational alternatives<sup>1</sup>, which (with the exception of the universities of art and music) are reserved to persons with a "Reifeprüfung" Certificate<sup>2</sup> (from AHS), a "Reifeprüfung" Certificate and TVE Diploma (from BHS), and to those with a completed university entrance exam. As an alternative to university study programs, *Fachhochschule* courses (i.e. the Universities of Applied Sciences) were established at the beginning of the 1993/94 academic year. Access is not restricted only to persons with one of the two above-mentioned "Reifeprüfung" diplomas, but possible also for persons with a relevant subject-related professional qualification.

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<sup>1</sup> These include Post-secondary Colleges for Teacher Trainer, Post-secondary Colleges for the Training of R.E. Teachers, Post-secondary Colleges for the Training of Vocational Teachers, Post-Secondary Colleges for Social Work, Post-secondary Colleges for the Training of Para-medical Staff, Post-secondary Courses (Kollegs), and Specialised Courses for Technical and Business Occupations.

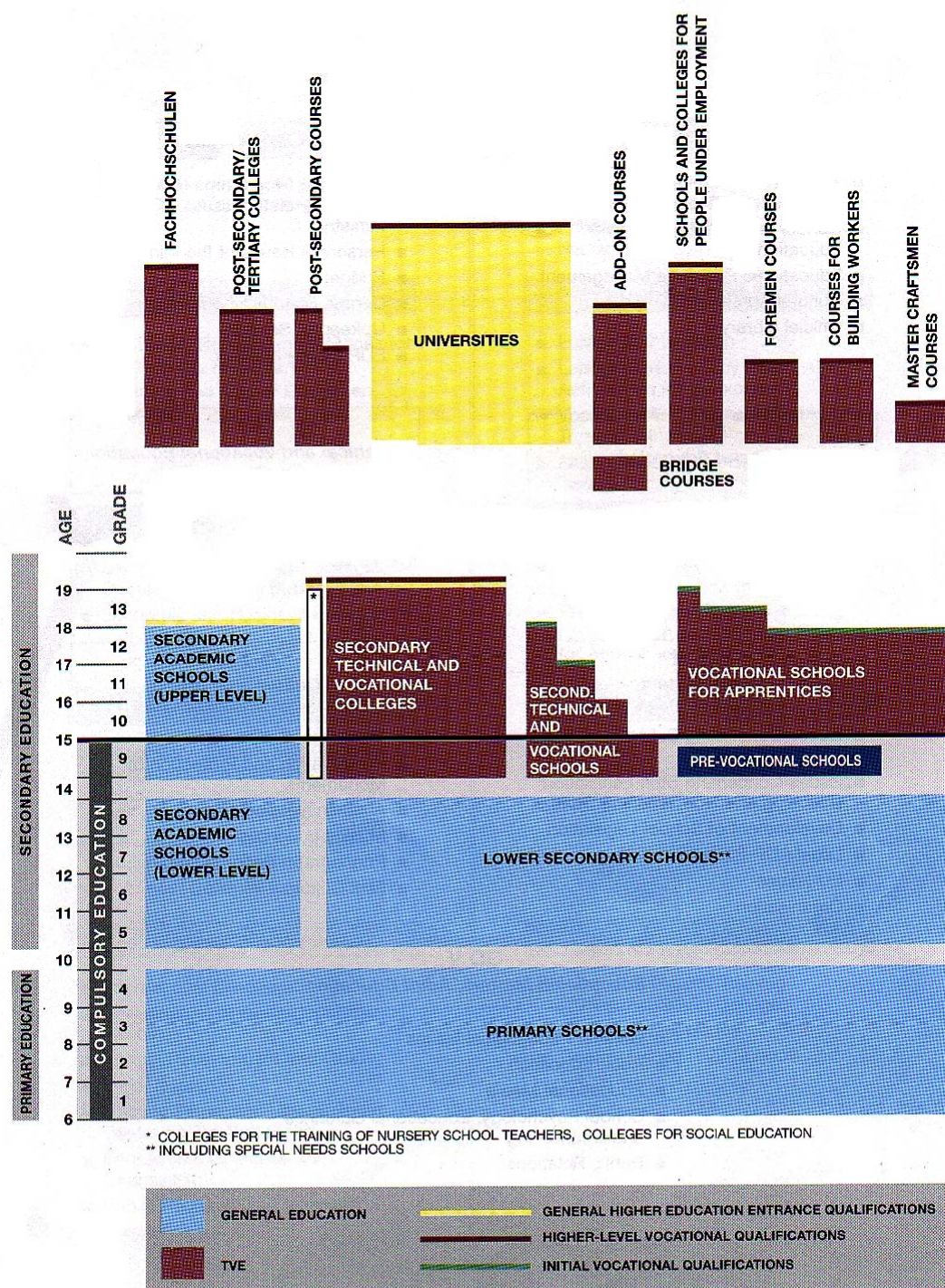
<sup>2</sup> In Austria, the "Reifeprüfung" (or "Matura") is a final exam in upper level academic secondary schools and secondary technical and vocational colleges, usually taken after 12 resp. 13 years of education. Matura also grants admission to universities or Fachhochschulen (colleges).



Figure 2.1: The Austrian education system

## THE AUSTRIAN EDUCATION SYSTEM

SIMPLIFIED CHART





### Educational expansion

The educational expansion mainly took place within the unchanged structures of the Austrian educational system. For Austria an early differentiation at secondary level I and dominance of the apprenticeship-system at secondary level II is typical. As a result of the educational expansion over the past 25 years a far-reaching higher qualification has been observed. There has been a steady decline in the share of persons with compulsory schooling as their highest qualification. Currently, their share in the total population is at about one third. This process is limited practically exclusively to the young cohorts, whose educational integration has been increasing over time<sup>3</sup> (the percentage of teenagers leaving the education system immediately after compulsory schooling without taking up a school-based track nor an apprenticeship training program is in the range of 3-10%<sup>4</sup>). Of the residential population aged 20-24, currently only about 17% have not obtained any qualification beyond compulsory schooling.

This educational expansion has been fostered, above all, by schools providing a higher level of education, in particular by the BHS. At present, about one quarter of young people opt for this school form after compulsory schooling.

In an international comparison the Austrian dual system represents a special case, in particular as far as its importance for the national education system is concerned<sup>5</sup>. In the age group of the 16-year-olds (thus, at about the end of the compulsory schooling period) the share of young people taking up an apprenticeship training program is roughly 40%. Regarding content and structure, the apprenticeship training system is oriented strongly towards (individual) company interests and is "market driven" to a large degree. This means that manifold determinants (in particular cost-benefit considerations) have an influence on the demand for apprentices.

Adding all vocational forms of training, currently nearly 80% of young Austrian people at secondary level II are in one of these vocational post-compulsory training forms. About 55% of these students are in full-time vocational schools, the other 45% are in the dual system. Therefore, the Austrian vocational system distinguishes itself through its combination of an elaborated apprenticeship system and a comprehensive vocational schooling system.

Austria's relatively low university graduation rate of 7% compared to other countries (measured on the basis of the working population) is basically due to the different structure of Austrian universities (until recently, only *long* first-degree programs existed) and, in general, to the different structure of the Austrian qualification system (high importance of the BMS and the BHS). Until recently, the university sector was characterized by distinct elements of structural conservatism. The expansion was for a long period not accompanied by a diversification process with regard to institutions or the length of study courses. Most recent developments in the tertiary education sector mark profound changes. These mainly concern

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<sup>3</sup> Whereas in 1987 approx. 61% of the 18-year-old population had been in the education system, this figure rose to slightly less than 70% by 1997.

<sup>4</sup> Since there exist no student flow statistics in Austria, estimations have to be used.

<sup>5</sup> Only in Germany and Switzerland the dual system has a similar importance as in Austria.

the introduction of the *Fachhochschulen* and the establishment of *Bakkalaureats* in some courses of study.

The Austrian education system is determined by qualifications (this means that professionally relevant skills are taught in the education system<sup>6</sup>), for which reason it is characterized by a high share of specific vocational education and training. Due to the combination of a well-developed apprenticeship training system with an extensive full-time school-based VET system (at secondary level II), occupationally relevant skills are imparted in the education system. This implies, furthermore, a pronounced stratification, i.e. a relatively low degree of mobility between vocational and school-based programs.

However, the education system does not provide qualifications only. Due to its structure, social opportunities are distributed and/or social inequalities are (re)produced and legitimated by formal diplomas. Allocative aspects are the result of graduates being directed, in accordance with their qualification levels, to specific professional and other roles. At the same time such formalised education systems imply a linear hierarchy from kindergarten to university. This leads to a trend towards those diplomas that promise more privileges for the individual. Moreover, it becomes more and more necessary to acquire diplomas at an ever higher level to achieve professional (entry) positions at a particular level. Therefore, an increasing number of people in all social strata orient themselves towards higher qualification forms, which is clearly reflected in the structure of educational expansion.

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<sup>6</sup> In contrast to education systems determined by qualifications, systems determined by organizations concentrate on general (basic) education; work-related skills are acquired at the workplace only.

### 3 The Data

The special program of the Austrian microcensus from June 1996 contained a questionnaire on education as well as on the biography of birth. The data of this survey was the source for the analyses in this paper. However, only a few of the questions were of interest, namely:

- kind of graduation in compulsory education (multiple answer possibility)
- highest education of the individual's parents
- municipality type (place where person lived at the age of fifteen)

In contrast to the basic program of the microcensus, the special program is voluntary. Since individuals for some reasons often refuse to answer the questions, due to lack of interest or embarrassment, we have to consider a systematic error. Particularly in a survey on education we can expect less interest in the program from individuals with a lower education level; consequently, some caution in usage of the results is advisable.

For the analyses certain recoding was required. In the original database, different compulsory school types were considered, because the Austrian compulsory education system changed over the years. In the past, no prevocational school (Polytechnische Schule) existed and, furthermore, pupils had the possibility to extend primary school (Volksschule) up to the 8<sup>th</sup> grade. Additionally, we have to consider the special school for handicapped or maladjusted children (Sonderschule). These school types have been allocated to the category of the "lower secondary school" (Hauptschule). Graduates from lower academic secondary school (AHS) remain in their category. Table 3.1 specifies the variables used for the analyses in this paper.

**Table 3.1: Variable description**

Variable	Description	Type
<i>Gender</i>	Gender	Categorical with the categories 0 female 1 male
<i>Municip</i>	Municipality type, where lived at age of fifteen	Categorical with the categories 0 rural 1 urban
<i>Citizen</i>	Citizenship	Categorical with the categories 0 Austrian 1 foreign
<i>Educ_com</i>	Compulsory education	Categorical with the categories 0 Lower secondary school 1 Lower academic secondary school
<i>Educ_high</i>	Highest education of the individuals interviewed	Categorical with the categories 1 Compulsory 2 Vocational 3 Matura <sup>7</sup> 4 University
<i>Educ_par</i>	Education of parents (highest value of father or mother)	Categorical with the categories 1 Compulsory 2 Vocational 3 Matura 4 University
<i>cohort</i>	Five-year cohorts from 1936 to 1980	Continuous (interval)
<i>gewl</i>	Adjusted weight by the population structure of the total population of Austria	Continuous

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<sup>7</sup> cf. footnote 2 for the description of the term “Matura”.

## 4 Influence Factors on Compulsory Education

Some of the most important factors that influence the choice of school type in compulsory education are

- gender,
- rural versus urban municipality, used as proxy for availability of academic secondary schools,
- education of parents.

In this chapter the distributions of these factors and combinations of them will be explored. Since the present situation in compulsory education is of interest, only those born between 1966 and 1980 were considered for the descriptive analyses in this chapter.

As Table 3.1 shows, gender has only a minor influence on the choice between the ordinary and the academic secondary school. Altogether three quarters of the individuals graduated from lower secondary school (Hauptschule), and only one quarter from lower academic secondary school (AHS).

**Table 4.1: Compulsory education and gender**

Gender	Compulsory education	
	Lower secondary school	Lower academic secondary school
<b>female</b>	73.6%	26.4%
<b>male</b>	75.7%	24.3%
<b>Total</b>	74.7%	25.3%

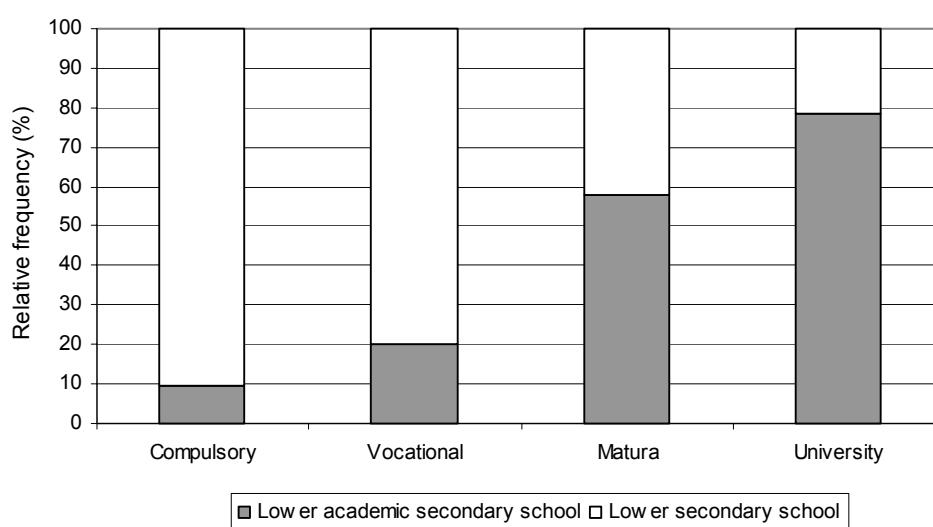
A completely different picture emerges if one includes the influence of the municipality type in which individuals lived at the age of fifteen. In view of the fact that in rural municipalities the density of lower academic school is much smaller, we can expect a lower proportion of graduates from this school type. As shown in Table 4.2, in rural regions only 17.4% graduated from lower academic secondary schools, as compared to 39.4% from urban municipalities.

**Table 4.2: Compulsory education and municipality type**

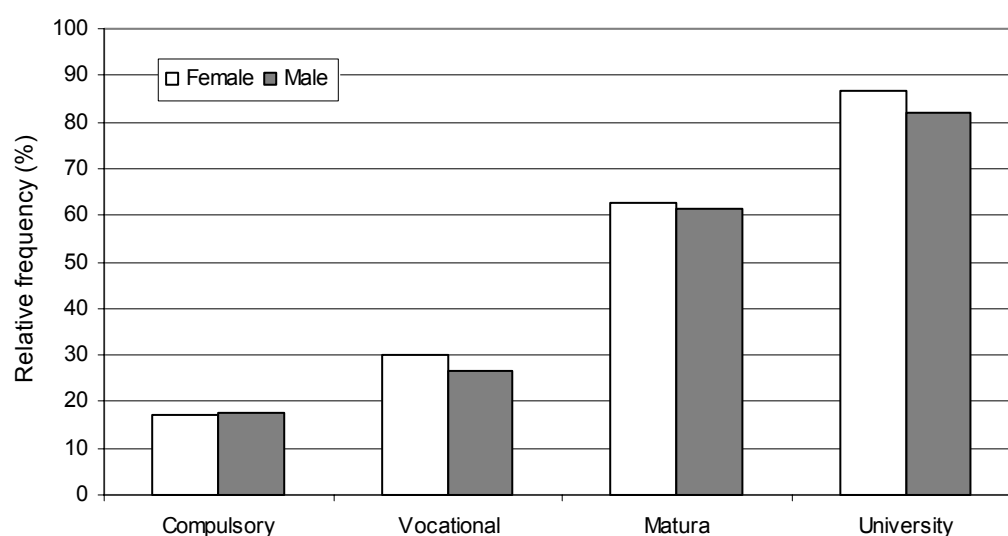
Municipality type	Compulsory education	
	Lower secondary school	Lower academic secondary school
<b>rural</b>	82.6%	17.4%
<b>urban</b>	60.6%	39.4%

The influence of the educational background of parents on the choice of school type in compulsory education is a basic issue in this paper. Figure 4.1 shows the proportion of graduates from lower secondary school and lower academic secondary school depending on the education of the parents. The strong influence of this factor can clearly be seen. While 80% of those whose parents have a university degree graduated from a lower academic secondary school, only 10% of those whose parents have just compulsory education did so. Put differently, the higher the education of parents, the higher is the chance of an individual to graduate from a lower academic secondary school.

**Figure 4.1: Compulsory education and education of parents**



**Figure 4.2: Lower academic secondary school graduates (in percentage) in urban municipalities and education of parents divided by gender**

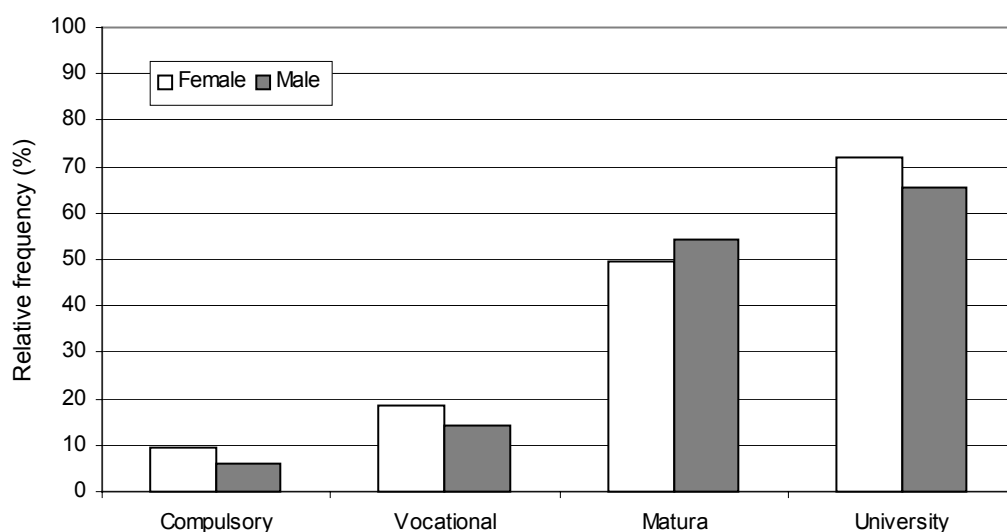


In Figure 4.2 and Figure 4.3 municipality and gender is additionally taken into consideration. The strong influence of the education of parents is shown again, with the same effect in rural



and urban municipalities. Comparison of Figure 4.2 and Figure 4.3 reveals a much higher proportion of lower academic secondary school graduates in urban municipalities. Considering gender, it is noticeable that in every category the proportion of female graduates from lower academic secondary schools is slightly higher than those of male graduates, except in rural municipalities, when parents have matura level. Here the proportion of male is 5% higher than the female one.

**Figure 4.3: Lower academic secondary school graduates (in percentage) in rural municipalities and education of parents divided by gender**

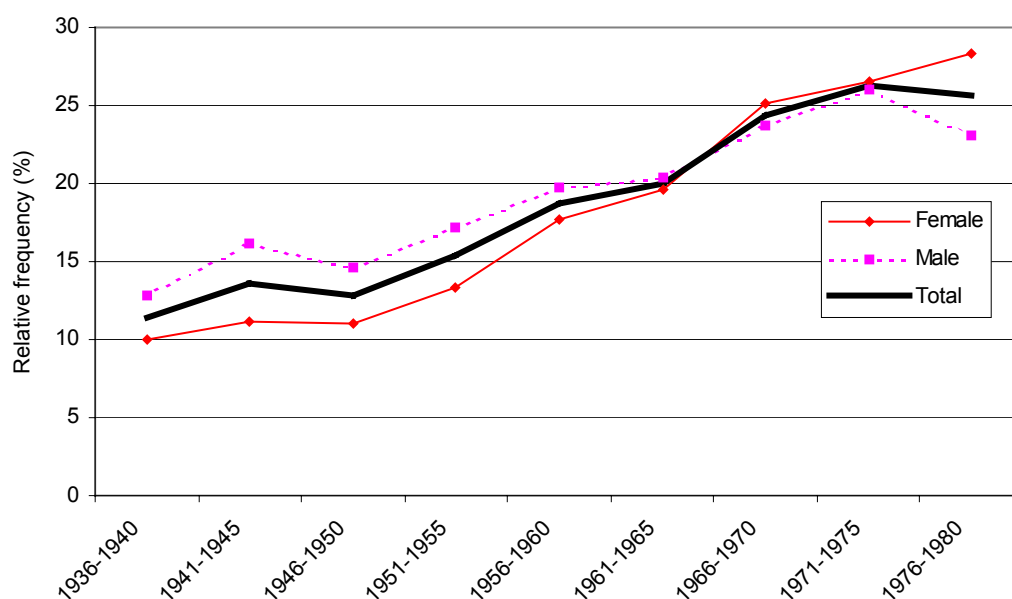


## 5 Influence Factors over Five-Year Cohorts from 1936 to 1980

In this section we examine the developments of the proportions of lower academic secondary school graduates, depending on gender, municipality and education of parents, over the five-year cohorts from 1936 to 1980.

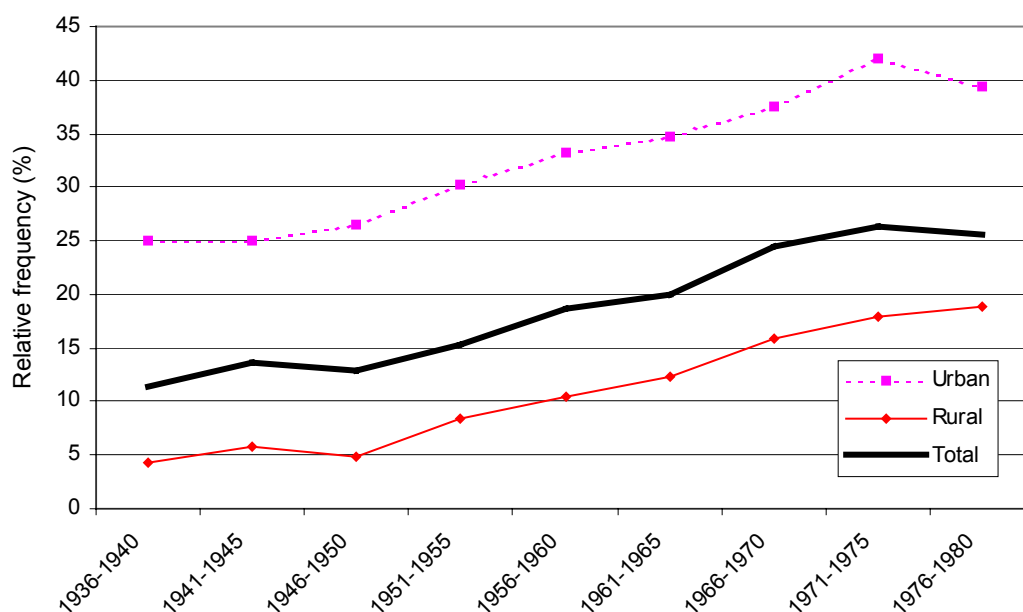
The overall number of graduates increased considerably from around 12% to more than 25%. Figure 5.1 reflects this clear trend to academic secondary schools. The difference between male and female lower academic secondary graduates of about 10%-points in the cohorts from 1936 to 1955 reduces over time, becomes even in the cohort 1961-1965, and stays this way until the last cohort, where we have an unexplained decrease of male graduates.

**Figure 5.1: Lower academic secondary school graduates (in percentage) conditional on gender over five-year cohorts from 1936 to 1980**



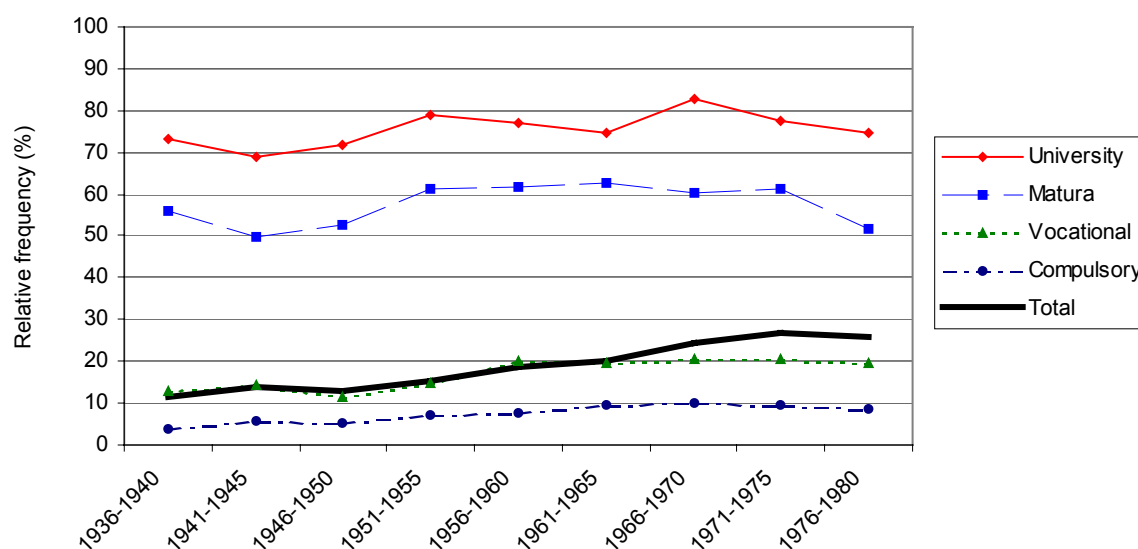
As mentioned in the previous section, in rural municipalities the provision of academic school is rather poor. The drastic differences between rural and urban municipalities are shown in Figure 5.2. The increase of graduates over the last decades concerns rural as well as urban municipalities in the same way. As a result the enormous discrimination against rural municipalities remains at around 20%-points.

**Figure 5.2: Lower academic secondary school graduates (in percentage) conditional on municipality type over five-year cohorts from 1936 to 1980**



Looking at the influence of the educational background of parents and the progress of the proportions of lower academic secondary school graduates over the last decades (cf. Figure 5.3), it is obvious that these differences slightly changed in favour of individuals of parents with lower education. Nevertheless, there is a tremendous difference between these categories, where individuals of parents with a lower education are vastly disadvantaged.

**Figure 5.3: Lower academic secondary school graduates (in percentage) conditional on the education of their parents over five-year cohorts from 1936 to 1980**

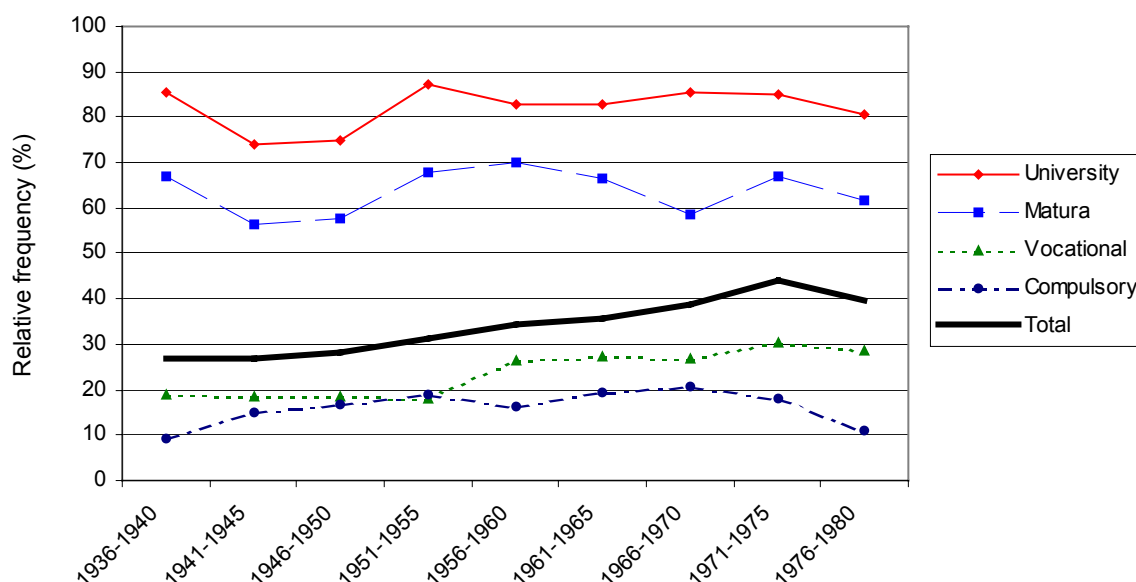


The increase of graduates of parents with a vocational education is clearly seen, where the proportion rose from 13% to 20%. Furthermore, the increase of individuals of parents with just compulsory education is noticeable as well. Here the proportion rose from 4% to 10%.

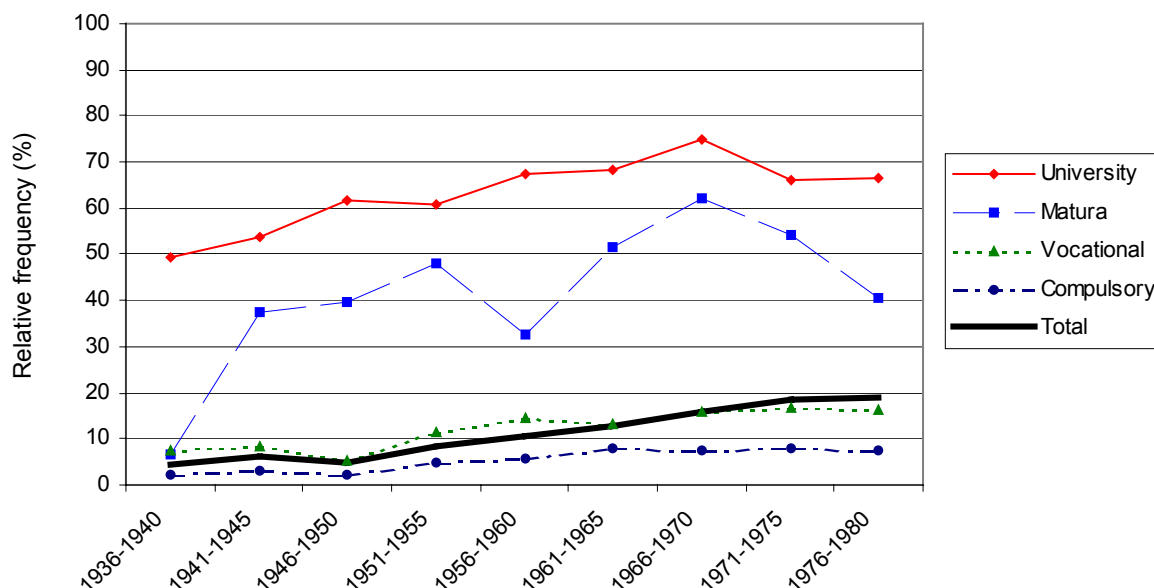
These raises mainly caused the increase of the proportion of the entire lower academic secondary school graduates since the categories where parents have a higher education show only a minor change. The proportion of graduates of parents with a university degree varies at around 80% and the proportion individuals of parents with matura is stable at around 60%. In the last cohort, we can observe a decrease in every category, which we still cannot explain. Though, we suppose, that this decrease does not apply to the total population.

Figure 5.4 and Figure 5.5 show the proportions of lower academic secondary graduates, conditional on the education of their parents, for rural and urban municipalities. Because of the small sample size within the cohorts and strata, the graphs vary to a greater extent; thus the results have to be handled with some caution. Besides the discrimination against rural municipalities some differences in the trends of the graphs can be observed as well. Whereas in rural municipality the proportion of individuals of parents with a university degree or matura increased over the cohorts noticeably, saturation for this category occurred in urban areas. For the category of the university an increase from 50% to around 70% can be observed. For the matura category the increase was from 40% to 60% (for both categories, outliers are not taken into account). In urban areas the increase of the proportions is confined to the individuals of parents with vocational or compulsory education. The low numbers in the cohorts 1936-40 and 1956-60 (cf. Figure 5.5) can probably be traced back to the small sample size.

**Figure 5.4: Lower academic secondary school graduates (in percentage), living in an urban municipality at the age of fifteen, conditional on the education of their parents over five-year cohorts from 1936 to 1980**

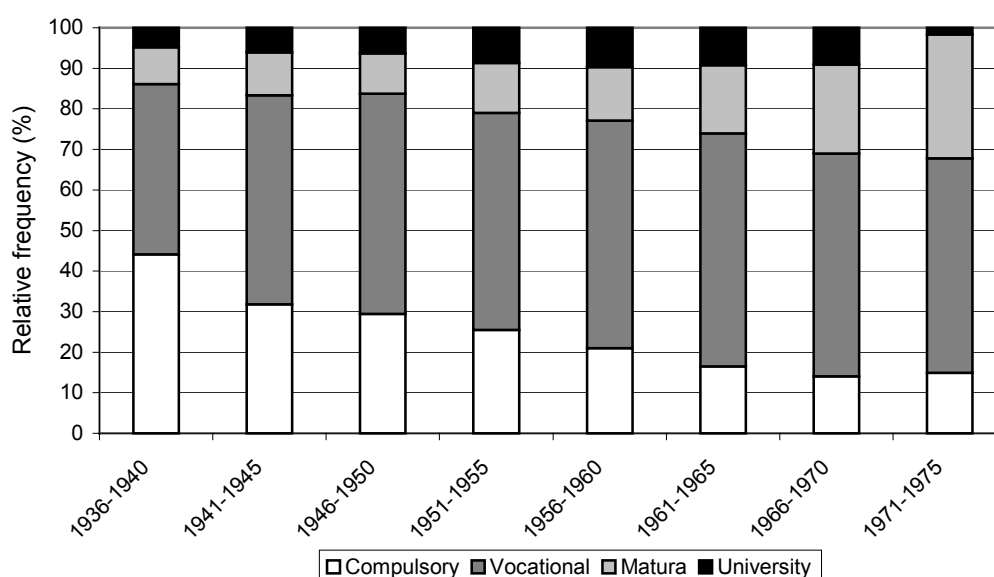


**Figure 5.5: Lower academic secondary school graduates (in percentage), living in a rural municipality at the age of fifteen, conditional on the education of their parents over five-year cohorts from 1936 to 1980**



In Figure 5.6 an additional look at the highest education of the interviewed individuals and the development over the last decades is taken. As expected, an increase of the proportion of individuals with a higher education can be observed. The reduction of the proportion of individuals with compulsory education from more than 40% to 13% is remarkable. In the last cohort many individuals were still in the education process, thus the low proportion of university graduates is reasonable.

**Figure 5.6: Highest education of the interviewed individuals (only special program) over five-year cohorts from 1936 to 1975**



## 6 Logistic Regression of the Influence Factors

To reveal the influence of gender, municipality type and education of parents, and, moreover, to estimate the probability of an individual for having been in lower academic secondary school in relation to any combination of the influence factors, a logistic regression was carried out<sup>8</sup>. About 2100 to 3000 cases per cohort were included in the analyses; missing cases were excluded. The analyses were performed in the statistical software package SPSS.

**Table 6.1: Logistic regression coefficients and standard error**

Dependent Variable: <i>educ_com</i> (Compulsory Education)									
Independent Variables	Cohort								
	(1) 1936-40	(2) 1941-45	(3) 1946-50	(4) 1951-55	(5) 1956-60	(6) 1961-65	(7) 1966-70	(8) 1971-75	(9) 1976-80
<i>female</i>	-0.621 (0.179)	-0.780 (0.156)	-0.612 (0.150)	-0.271 (0.134)	-0.182 (0.113)	-0.077 (0.107)	0.253 (0.107)	0.200 (0.108)	0.083 (0.109)
<i>rural</i>	-1.358 (0.186)	-1.374 (0.163)	-1.473 (0.157)	-0.999 (0.141)	-0.920 (0.118)	-0.819 (0.114)	-0.603 (0.112)	-0.723 (0.115)	-0.713 (0.117)
<i>compulsory</i>	-3.710 (0.308)	-3.331 (0.266)	-3.258 (0.292)	-3.257 (0.294)	-3.158 (0.230)	-2.884 (0.239)	-3.390 (0.233)	-3.271 (0.219)	-3.211 (0.226)
<i>vocational</i>	-2.784 (0.306)	-2.693 (0.262)	-2.794 (0.295)	-2.850 (0.296)	-2.352 (0.225)	-2.319 (0.231)	-2.668 (0.219)	-2.472 (0.191)	-2.239 (0.176)
<i>matura</i>	-1.033 (0.345)	-0.753 (0.297)	-0.868 (0.319)	-0.866 (0.322)	-0.985 (0.264)	-0.538 (0.268)	-0.944 (0.242)	-0.904 (0.220)	-0.947 (0.199)
<i>university</i>	0	0	0	0	0	0	0	0	0
<i>intercept</i>	1.553 (0.300)	1.623 (0.254)	1.643 (0.287)	1.548 (0.288)	1.421 (0.227)	1.247 (0.230)	1.433 (0.213)	1.543 (0.192)	1.246 (0.182)
Chi-square df = 5	376,3	460,1	453,2	398,7	466,7	439,7	540,8	525,5	427,5
Nagelkerkes R <sup>2</sup>	0.349	0.352	0.332	0.268	0.249	0.225	0.280	0.293	0.252

The Chi-square statistics of the model are highly significant for each cohort (p-value=0.000), which shows, that the relationship between the dependent variable and the model is probably real and not due to sampling fluctuations. The coefficient of determination R<sup>2</sup> would be useful to indicate the proportion of the predictive capability. The Nagelkerkes R<sup>2</sup> is one of the various pseudo R-square, developed for binary response models, as an equivalent of the usual

<sup>8</sup> cf. The appendix for theoretical specification of the logistic regression.



coefficient of determination. Although, the  $R^2$  of the logistic regression is calculated in a different way than the  $R^2$  in the ordinary linear regression, it can be interpreted to a great extent in the same way. For the several cohorts the Nagelkerkes R-squares vary around 0.25 to 0.35, which are moderate to good values for the logistic regression; consequently, these variables are fair predictors.

The regression coefficients of the logistic regression, listed in Table 6.1, explain for each cohort separately the influence of the several influence factors on compulsory education. Most of the regression coefficients are significant, except for gender (female) in the cohorts 5, 6, 8 and 9. For females a disadvantage in the past can be seen. Thereafter (cohorts 4 to 6) the situation for them improved, until the difference between male and female is no longer significant. The development for rural municipality is similar, where the negative influence of around  $-1.3$  slightly reduces over time and becomes stable in the last cohorts with around  $-0.7$ .

For the four categories of the variable education of parents dummy variables were built, whereby the last category, of course, is linear dependent to the rest of the categories. Therefore the regression coefficients show not only the influence on compulsory education but also the distance to the category university. In the descriptive part of this paper the negative influence of the lower educational background of an individual's parents on his/her compulsory education has already been shown. This is clearly seen in the logistic regression coefficients of the category parents with compulsory education, where the negative influence decreases only slightly over the cohorts and stabilizes around  $-3.2$  in the last cohorts. A similar picture can be derived from individuals of parents with vocational education, where a slight increase from  $-2.8$  to  $-2.2$  is recognizable. The regression coefficients of the category parents with matura show only minor variations over the cohorts, and even out around  $-0.9$ .

For a further interpretation of the regression coefficients, one has to look at the odds ratio

$$\psi = \frac{p_1 / (1 - p_1)}{p_0 / (1 - p_0)} = e^{b_i},$$

which explains simply the partial effect, from changing a binary explanatory variable (or dummy variable) from one to zero, holding all other variables fixed<sup>9</sup>.

For the last cohort the regression coefficient for rural area is  $-0.713$ , therefore the odds ratio is

$$\psi = \frac{P(\text{lower academic secondary} | \text{rural}) / P(\text{lower secondary} | \text{rural})}{P(\text{lower academic secondary} | \text{urban}) / P(\text{lower secondary} | \text{urban})} = e^{-0.713} = 0.49.$$

Assuming that the odds ratio had been one, there would have been no difference between rural and urban municipalities. A ratio of 0.49 means that the relation of the odds<sup>10</sup> of rural

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<sup>9</sup> For derivation see appendix

<sup>10</sup> The odds is defined as  $p / (1 - p)$

and urban is 1:2. The odds ratio can be seen as a measure of the estimated probability for academic secondary school graduates among rural areas in association among urban areas.

In the FAMSIM+ model the calculation of the probabilities of an individual having certain characteristics, for any combination of the explanatory variable in the equation, has to be done. The following example will help to understand the principle.

For the cohort 7 (1966-70) in Table 6.1 the regression equation for the model is

$$\text{logit}(p) = \ln\left(\frac{p}{1-p}\right) = 1.433 + 0.253 \cdot \text{female} - 0.603 \cdot \text{rural} - 3.390 \cdot \text{compulsory} \\ - 2.668 \cdot \text{vocational} - 0.944 \cdot \text{matura}.$$

For a female, born between 1966 and 1970, living in a city at the age of 15, having a father or mother with a vocational education, the estimated probability for having graduated from the fourth grade lower secondary academic school is

$$\hat{p}_{\text{female,urban,vocational}} = \frac{e^{\text{logit}(p)}}{1 + e^{\text{logit}(p)}} = \frac{e^{1.433+0.253-2.668}}{1 + e^{1.433+0.253-2.668}} = 0.273.$$

This calculation can be performed for any combination of the explanatory variables or for any individual in the sample.

## 7 Conclusion

The main idea of microsimulation is that processes resulting from the actions and interactions of a large number of micro-units can best be explained by looking at the micro-units and their behaviour. One expects to find more stable behavioural relationships on the micro-level than in aggregated data that is affected by structural changes when the number or size of the micro-units in the population changes, even if the behaviour of the individual micro-units and their individual characteristics do not change. These expectations were fully met regarding the school choice investigated in this paper that can almost serve as showcase in this sense. While the proportion of children entering the secondary academic school has more than doubled in the last six decades, the behaviour on the micro level – that is, the school choice in dependence on parental educational attainment – has almost remained unchanged for all age cohorts since the 1960s: only 10% of children with parents of the lowest of the four educational levels distinguished enter a secondary academic school (a choice to be made at the age of 10) while more than 80% of the children with parents with the highest education level do so. Microsimulation allows to project these dynamics generated by the changing educational composition of parents into the future and given the stable behavioural relations on the micro level, the logistic regression model developed and estimated in this paper could be directly implemented as benchmark scenario into the FAMSIM+ model.

Besides the influence of the parent's education, the analyses showed a tremendous rural-urban differential regarding school choice, with the proportion of children entering the secondary academic school being 20%-points higher in urban areas than in rural communities, that means being double as high in relative terms. Controlling for the different education of parents this means a more than 50% higher probability to enter a secondary academic school for children with parents of vocational education living in an urban area compared to children living in a rural area. For children with parents of academic level this chance is around 20% higher. It can be expected that one of the main explanations of this regional differential lies in the different availability of secondary academic schools and is therefore also subject to education policies.

A complementary explanation for this urban/rural division may be different school choice contexts. In rural areas a positive selection-process into lower secondary academic schools seems to be at work (meaning a tendency that particularly children who have been very successful in the primary school are the ones to attain a lower academic secondary school). Whereas in urban areas a negative filter process seems to be at work: parents overwhelmingly try to put their children into a lower secondary academic school – only the less successful pupils of the primary schools (and the majority of children from migrant workers) will continue their educational “career” in a lower secondary school. This means that for same success-level of a pupil at the end of primary school, the probability to join one of the two forms of secondary education will differ depending on where he/she (or their parents respectively) lives. These dynamics also seem to be of a relatively stable nature.

In this policy context, microsimulation can serve as tool to answer various "what if" questions due to the construction of different simulation scenarios: how would the educational composition change over time if rural behaviour converges to urban behaviour?

In the context of the FAMSIM+ project, the school choice modelled here is the first of various behavioural modules and choices to be modelled that will be linked to the general model for Austria. Especially the complex situation at grade 9 will be a challenging research tasks, as the interaction with the labour market via the dual system will have to be implemented into the model. Regarding our modelling work that will lead to a general family microsimulation model for Austria, our expectations have been met in the sense that the inclusion of regional and parental characteristics will substantially improve the model of education. We furthermore showed that microsimulation might be the appropriate modelling approach also in the more isolated field of educational projections.

## Appendix

### Logistic Regression

The (ordinary) linear regression enables us to predict the value of a continuous variable in relation to one or several explanatory variables. However, in some studies, the dependent variable is an indicator for the presence or absences of a condition which can be coded 0 or 1, such as employed/unemployed, success/failure or simply yes/no. In this binary response models we are interested in the probability

$$P(y = 1 | x_1, x_2, \dots, x_k).$$

For instance,  $y$  can be an employment indicator, and  $\mathbf{x}$  denotes i.e. gender, marital status, education, and recent participation in a job-training program. The principle of the logistic regression is the same as in the ordinary multiple linear regression. However, instead of predicting a value we are able to predict the proportion  $p$  of individuals with a certain characteristics, respectively the probability of a subject having a certain characteristics.

For a binary outcome variable, coded 0 or 1,  $p$  is estimated by the proportion of one's in the sample. If  $p$  describes the proportion of individuals with a certain characteristic, then  $(1 - p)$  is the proportion of individuals who do not have this characteristic. The **odds**  $p/(1 - p)$  relates to these proportions, and describes the chance. If for instance 80% of patients with a certain disease can be cured then the chance for success is 0.8/0.2 or 4 to 1. In the logistic regression one estimates rather a transformation of  $p$  than  $p$  itself, the **logit transformation** or **log odds**

$$y = \text{logit}(p) = \ln\left(\frac{p}{1-p}\right).$$

Since the logistic regression is just a transformation of the depended variable, we obtain the model

$$y = \text{logit}(p) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_k x_k + \varepsilon,$$

and with the estimated regression coefficients the equitation becomes

$$y = \text{logit}(p) = b_0 + b_1 x_1 + b_2 x_2 + \dots + b_k x_k + e,$$

which is the logit of the probability of an individual having a certain characteristic. If we take the exponential of the logit transformation  $y = \ln[p/(1 - p)]$  and solve for  $p$ , we get the **logistic function**

$$p = \frac{e^y}{1 + e^y} = \frac{e^{\text{logit}(p)}}{1 + e^{\text{logit}(p)}} ,$$

thus we can predict the probability of a subject  $p$  for any combination of the prognostic variables<sup>11</sup>. The logistic function varies always between zero and one, since  $e^y > 0$  for all real numbers of  $y$ . At this point, the reason for the transformation becomes obvious, since without the logit transformation the fitted probabilities might be outside the interval  $[0; 1]$ .

For comparison of the proportions in two groups, the ratio makes more sense than a difference. The ratio of the odds in the two groups

$$\psi = \frac{p_1 / (1 - p_1)}{p_0 / (1 - p_0)}$$

is called the **odds ratio**. The logarithm of the odds ratio gives us

$$\ln(\psi) = \ln\left(\frac{p_1 / (1 - p_1)}{p_0 / (1 - p_0)}\right) = \ln(p_1 / (1 - p_1)) - \ln(p_0 / (1 - p_0)) = \text{logit}(p_1) - \text{logit}(p_0) = y(1) - y(0),$$

thus we get for a simple regression equation

$$y(1) - y(0) = \beta_0 + \beta_1 \cdot 1 + \varepsilon - (\beta_0 + \beta_1 \cdot 0 + \varepsilon) = \beta_1 = \ln(\psi) .$$

If we take the exponential of the logistic regression coefficient, we obtain the odds ratio

$$\psi = e^{\beta_1} .$$

which explains plainly the partial effect from changing a binary explanatory variable from one to zero, holding all other variables fixed. We can therefore estimate the odds ratio for any binary variable directly from the regression coefficient<sup>12</sup>.

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<sup>11</sup> An example can be found in chapter 6 of this paper

<sup>12</sup> An example can be found in chapter 6 of this paper



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Gedruckt mit Unterstützung des Bundesministeriums für soziale Sicherheit und Generationen sowie der Länder Burgenland, Niederösterreich, Oberösterreich, Salzburg, Tirol, Vorarlberg und Wien.